
SciencePro Project: Towards Excellence in Bilingual Teaching

Proyecto SciencePro: avances hacia la excelencia en educación bilingüe

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Abstract: This paper provides an account of the progress of SciencePro, an innovative, interdisciplinary and interinstitutional education project, whose ultimate aim is to improve student teachers' knowledge, abilities and attitudes for teaching Natural Sciences in a foreign language. The team is working on the development of good practices at university level: enhancing proficiency of cross-curricular competences, including scientific contents, knowledge and foreign language skills oriented to scientific discourse, with a view to developing a more appropriate teaching approach. The Practicum period is needed in order to test out the improvement of these specific professional competences, which should be more suitable to modern bilingual school contexts.

Keywords: innovation project; CLIL; Natural Science teaching; foreign language teaching; Practicum.

Resumen: El contenido de este artículo da cuenta de los avances de SciencePro, un proyecto de innovación educativa, de carácter interdisciplinar e interinstitucional, cuyo fin último se dirige a la mejora del conocimiento, aptitudes y actitudes de los futuros maestros para la enseñanza de la asignatura de Ciencias Naturales en una lengua extranjera. El equipo trabaja en el desarrollo de buenas prácticas –en el nivel universitario– que den lugar al dominio de competencias transversales –incluyendo contenidos científicos, conocimiento y destrezas en lengua extranjera orientadas hacia el discurso científico y un enfoque metodológico adecuado. El periodo de Prácticum nos sirve para comprobar la mejora de aquellas competencias profesionales específicas que más se adecúan a los contextos escolares bilingües.

Palabras clave: proyecto de innovación; AICLE; enseñanza de Ciencias Naturales; enseñanza de lengua extranjera; Prácticum.

SCIENCEPRO FUNDAMENTALS

Legal regulation of the professional profile of the bilingual Primary Education Teacher

In 1996, the Ministry of Education and Science and the British Council signed the agreement which aimed to develop integrated curricular projects in public schools. Some years later, the ORDEN EDU/6/2006 (4 January) was published. These legal documents regulated the setting-up of bilingual schools supported with public funds. Since then, the Primary Education system has undergone a radical change, and schools offering bilingual teaching have proliferated in our autonomous region, Castile and Leon. In 2016, around 600 publicly funded Primary Education schools offer at least two subjects taught in a foreign language, mainly English. This change, which may sound appealing to parents eager to provide better career opportunities to their children, must have sounded daunting to hundreds of teachers required to adapt their teaching skills to a completely new classroom environment in which the foreign language is no longer only a subject to be taught, but also a vehicle to teach through. To address this challenge, in 2008 the regional authorities created a specific Language Centre for in-service teachers (known as the CFPI) in order to improve bilingual teaching competences. Meanwhile, the Ministry of Education abolished the Teacher Education plans of the 1990s and published Real Decreto 1393/2007 and Orden ECI/3857/2007. The former system provided training in the form of a three-year training itinerary in the foreign language and gave the education system highly competent teachers which could respond to traditional school needs. The former qualification consisted of three academic years in which Foreign Language, Foreign Language teaching methodologies and Practicum internships were core areas. Surprisingly, however, in December 2007, just when bilingual schools were emerging in Castile and Leon, the new legislation -Orden ECI/3857/2007- considerably reduced the number of hours devoted to higher-level Foreign Language classes: less time was available for language training, and this was only intended for students doing the Qualification in a Foreign Language. The authorities seemed to have forgotten that, to foster quality in bilingualism at Primary Education level, Pre-service Teacher Training needs also to be spurred in the same direction. Guaranteeing the level of competence of teaching graduates is necessary in order to ensure the same learning opportunities for children no matter which school they attend.

It is striking that some years later, the administration authorities published a new law, Real Decreto 1594/2011 (4 November), which states that the only requirement to teach a non-linguistic subject in bilingual schools is to hold a B2

certificate in the foreign language. This would seem to be clearly insufficient, as it implies that Natural Sciences can be taught in English by any school teacher even if that person has no methodological training directed to bilingual scientific learning contexts.

We should note, however, that in reality, most teachers responsible for “Natural Sciences¹” in bilingual schools have obtained a university teacher qualification in a Foreign Language, which includes the development of specific competences from the linguistic and methodological perspectives. So the education system seems to understand that teachers who have qualified in English at Pre-service Teacher Training level are the most suitable ones to undertake content teaching in English. Implicitly, then, they are perhaps also assuming that some competences beyond language certificates are also necessary for correct bilingual teaching performance.

Interdisciplinary and interinstitutional work

In view of the challenge that teaching in bilingual classrooms involves and the lack of specific training offered by the University, schools in our region have asked for cooperation and collaboration between the different education levels –Primary Education and Higher Education– in order to ensure that professionals who are qualifying can properly deal with the real needs of bilingual education.

Our dialogue with bilingual school agents during the practical training of student teachers led us to perceive that the language requirement is not enough for quality teaching. Teachers in bilingual schools should not only have linguistic and communication skills in the other language and specific knowledge of the subject to be taught, but also theoretical and practical training in the use of the foreign language oriented towards the classroom discourse, as well as a good command of suitable methodology.

So, on the basis of real experience, not only the legal framework, it is obvious that the course programme for student teachers doing Qualifying Programmes in English must be planned according to the new demands of bilingual education. Therefore, in order to redesign course syllabuses, the relation between schools and Teacher Education at University is vital, as is interdisciplinary work on an academic level. In order to transform pre-service training of school English teachers, SciencePro Project was launched as an up-to-date collaborative educational project which –showing a deep sense of responsibility (Martínez Domínguez, 2014)–

1 Our project focuses on Natural Sciences as it is one of the main subjects chosen to be taught through English by schools in Castile and Leon.

unites bilingual education schools, and academic staff from three different disciplines at the Faculty of Education and Social Work in the University of Valladolid. SciencePro, therefore, has a deeply innovative dimension arising from the synergy of the following aspects:

- (a) Associations and strategic relations between disciplinary components specific to university areas at Pre-service Teacher Training level: namely, experimental science education, foreign language teaching and English as a foreign language, fostering an institutional commitment towards the construction of knowledge (León Guerrero & López López, 2014).
- (b) Design and unification of pedagogic material and scientific experiments in Pre-service Teacher Training appropriate to bilingual education.
- (c) Intellectual outputs as regards bilingual science education, which are the result of joint contributions by lecturers and teachers during pre-service university training and school experience in the “Practicum” (school training placements).
- (d) The effects of this research, which is expected to have a profound impact on training at University Initial Teacher Education and at in-service teaching levels.

SciencePro stakeholders

The idea of working together in a collaborative way at different educational levels began to take shape in 2013, and it crystallized in the form of SciencePro in 2014. We requested the support of the University of Valladolid for the creation of an Innovative Education Group in order to participate in an Innovative Education Project which would focus on the training of specific competences. In this vein, the agents that we believe necessary to work productively on this project are:

- Lecturers and other teachers in the Faculty of Education and Social Work of the University of Valladolid, belonging to the three aforementioned areas -a total of ten;
- School teachers with experience in bilingual education who, we knew, were very supportive of targeting pre-service training at “know-how” in the subjects taught through a foreign language -a total of twelve;
- Student teachers qualifying in English as a Foreign Language, who would be intentionally selected to actively participate -a total of twelve; and
- Professionals from other education areas (local administration and other education levels) -a total of four.

The schools currently working with us are: CEIP Narciso Alonso Cortés (Valladolid) which has a British Council Bilingual Project, CEIP Francisco Pino (Valladolid), Centro Cultural Vallisoletano (Valladolid) and CEIP Margarita Salas (Arroyo de la Encomienda, Valladolid). The latter three are bilingual schools through ORDEN EDU/6/2006. The issue to take into account here is that the teaching in these schools differs not so much in terms of the methodological perspective (Content and Language Integrated Learning –CLIL– in all the cases), but in the curricular implementation.

Consequently, working groups have been established at two different levels: 1. among university lecturers from different subject areas the Degree in Primary Education; and 2. among university lecturers and teachers in Primary Education schools. This interdisciplinary and interdepartmental work is designed to promote the development of specific competences in relation to: a) specific contents within the subject of Natural Sciences, b) the foreign language, particularly oriented towards the development of scientific discourse in the Primary school classroom, and c) proper methodologies allowing the effective application of this knowledge.

Bilingual school teachers' needs

Taking into account the new tasks that are entrusted to bilingual school teachers, we can determine that pre-service training must be focused on: knowing how to handle *Basic Interpersonal Communication Skills* and *Cognitive Academic Language Proficiency* (Cummins, 1979); an ability to develop communication skills and to activate higher cognitive processes in students (Bloom, Mesia & Krathwohl, 1964); and skills for promoting interpersonal understanding and the development of self-consciousness and “other” conscious (Coyle, 2007). Furthermore, they have to master the most appropriate methodologies to carry out the process of teaching and learning of non-linguistic content in a foreign language.

As these tasks are being performed, in many cases, by teachers with just a foreign language qualification, it is our duty as pre-service teacher trainers to educate undergraduates so that they can effectively teach non-linguistic subjects.

Pre-service Teacher Training: adaptation to new needs

It is therefore vital to adapt university Pre-service Teacher Training to this new scenario in which “Science through English” is at centre stage. SciencePro represents a response to this need, providing teacher students with more realistic and complete training. The aim of the project is, therefore, to tackle the development

of specific competences in the teaching of Natural Sciences through English using an experimental methodology at university level.

To provide a solid grounding for our project, we interviewed Primary teachers teaching Natural Sciences through English, asking them about the shortcomings of our student teachers during the internship. According to them, student teachers face difficulties which have to do with insufficient training at three different levels:

- Scientific knowledge. 4th year student teachers usually still present a low command of: the scientific contents to be developed in Primary Education, and the specific methodologies used in scientific disciplines. Coming from mainly humanistic pre-university training programmes, many of the Education students lack contact with basic scientific fundamentals, which makes it hard for them to understand and acquire knowledge at a more complex level.
- Language command. Even a properly certified B2 level in English does not guarantee that communicative interaction in the Natural Science classroom will be effective. B2 users without specific training in scientific discourse and discourse strategies are prone to fail in the communicative act in both directions. On the one hand, students find difficulties both in using different strategies to explain concepts and procedures and in pronouncing scientific terms correctly (as they suffer interference from Spanish due to the words' Graeco-Latin etymological origins). On the other, the development of good communication skills in children may not be properly encouraged and tackled.
- CLIL approach. Only those student teachers qualifying in English are lucky enough to receive some training in *Content and Language Integrated Learning* (Ball, Kelly & Clegg, 2015; Coyle, Hood & Marsh, 2010), which is thought to be the most effective way to teach a subject through a foreign language. However, good practices in CLIL cannot be properly acquired and used unless trainees experience them through formal science learning situations before they start teaching at schools.

It seems, then, that today's new teachers should necessarily display both a finer sensibility towards science education in this new bilingual school context, and more specific competences in all the different aspects involved in Natural Science teaching through English.

In order to make the training process effective, we believe it is quite important that the students experience the need to broaden their repertoire of knowledge

and their teaching strategies. Hence, it is crucial for the teaching and learning process to adopt a *learner-centered approach* (Bonk & Cunningham, 1998; Norman & Spohrer, 1996; Weimer, 2002). In this regard, we should give the students the possibility to discover their own training weaknesses by themselves so that they can acquire a high degree of autonomy, always assisted by the different agents involved in Pre-service Teacher Training, that is, university lecturers and internship tutors.

CLIL approach for teaching Natural Sciences

Pupils should begin to acquire scientific literacy from their early school years. For this reason, initiating this process at early ages and focusing attention on the ongoing teacher training programmes promises substantial gains to address the problem of bilingual teaching of scientific subject matters. Now more than ever, the literacy process is taking on an added value which raises its status to a multilingual condition (Sollars, 2002), on account of the language diversity present in educational contexts. In addition, it is notable that the teaching *of* and *through* languages is growing in importance, a point which the CLIL approach has emphasized as a key factor which serves bilingual learning.

CLIL is premised on the view that it is possible to achieve effective integration of the contents of a non-linguistic subject and the contents of the foreign language itself. The integration can be duly accomplished as a result of the appropriate and refined combination of the wide variety of CLIL components, namely: the 4Cs framework (Content, Cognition, Communication and Culture) (Coyle, 2007); the context; the Primary school curriculum; the adjustment of the linguistic code employed -language *off/for/through* learning; and so on. This means that the contents and the target language cannot be treated as detached compartments, but as a single whole achieved by a converging process of the components aforementioned. Primarily, the foreign language is conceived as a mere communication vehicle through which the curricular contents of the particular non-linguistic subject are transmitted. In response to the monolingual tradition held by a large number of European educational contexts, new models and education systems are being gradually introduced, including bilingualism, among the priorities for action. This is embodied in the creation of bilingual schools, whose qualified teachers, responsible for the teaching of areas such as the Natural Sciences, can teach professionally through a foreign language. The new teacher profile that emerges from this perspective requires quality training in CLIL methodology, likely to be complemented by other innovative methods and approaches and by far-reaching potentialities.

METHODOLOGY

The main aim of this project is to improve the quality of the professional competences (European Commission, 2013; Perrenoud, 2004, among many others) of teachers working in Primary Education levels (6 to 12-year-old children). We intend to train teachers through cooperative work, so they can gain the necessary competences to perform Science teaching in bilingual contexts. The implementation of the project has been organized in overlapping phases in time.

Analysis of legal documents: Pre-service Teacher Training syllabi and Primary Education curriculum. This analysis was carried out in order to estimate the convergences and divergences to be taken into account so as to work towards the modification or adjustment of these documents to ensure coherence and a positive effect on educational quality.

Training courses in CLIL and EMI (English as a Medium of Instruction) aimed at all the university lecturers involved in the project: CLIL and EMI are the two methodological approaches on which this project relies, along with other methodologies associated with the didactics of experimental sciences, such as experimentation, the scientific method and learning by inquiring, doing or discovering.

Observation of bilingual schools teaching Natural Sciences. We do this through job-shadowing activities and by mentoring our students during their placements in the schools.

Designing cooperative and interdisciplinary education course projects and modifying the syllabi of the Degree in Primary Education with a Qualification in English.

FOCUSED LESSONS

As far as the methodological principles are concerned, the meaningful role of both Task-based Language Learning and Teaching (TBLT) (Ellis, 2003; Estaire & Zanón, 1990) and CLIL approach should be stressed. In fact, the integration of these approaches is what truly makes a difference in bilingual education, especially when teaching Natural Sciences in Primary schools through a foreign language. The common underlying path between Task-based approach and CLIL is supported by the communication process in the target language so as to effectively reach the acquisition of the disciplinary contents.

On the basis of these approaches, in the assignments proposed from the university courses involved, we place further attention on experimental learning by means of cooperative and peer learning, within the framework of the procedural

dimension of learning (learning by doing), as well as in the classroom atmosphere.

Thus, the students in Pre-service Teacher Training are required to reflect on these general principles by putting them into practice during their Practicum period.

TBLT and CLIL are consciously foregrounded in the theoretical and practical perspectives in some undergraduate courses focusing on methodology, but they are also used and unconsciously acquired in foreign language lessons.

Foreign language lessons are mainly focused on getting used to and building on school scientific discourse. The use of a foreign language should not hinder good science teaching during the school Practicum; so the more comfortable student teachers feel with scientific discourse, the more confident they will be at searching for scientific information in that foreign language, and the more time they will afford to improve their own teaching practices.

In order to build on useful down-to-earth scientific school discourse, we pay detailed attention to lesson planning, sticking to cognitive constructivist learning approaches and other communicative criteria:

- Comprehension before production (Edenlebos, Johnstone & Kubanek, 2006; Krashen, 1982): Specific discourse skills cannot be developed and properly used unless the ideas to be expressed are fully understood by the speaker.
- Concreteness before abstractness (Piaget, 1990): Abstract concepts cannot be effectively defined and transmitted to the learner or child if the learner has not been previously exposed to sensory-motor concrete impressions regarding that concept.
- Zone of Proximal Development and scaffolding (Vygotsky, 1978; Wood, Bruner & Ross, 1976): Any comprehension task on a scientific concept must be sequenced in increasing difficulty under the guidance of the teacher, starting from the basic or simple idea and following all the necessary steps to get to the most complex or abstract meaning.
- The correct acquisition of scientific collocations and pronunciation of terminology makes the Natural Science teacher feel more comfortable with the language.
- Good science teaching in a foreign language requires the use of linguistic and non-linguistic cognitive strategies, such as paraphrasing, comparisons, schemata, models, sensory-motor experience or mathematical calculations.

Since the development of scientific discourse for school teaching is, as it seems, a very intricate task, we think our foreign language course should follow the in-

put-output sequence and try to emulate Krashen's theory of acquisition (Krashen, 1982), which assumes that the learners need to be exposed to a rich and varied amount of input before they start producing some output.

When considering the *input* to which students should be exposed, delimiting the scientific content we are working on is important, as well as planning a from-easy-to-difficult input sequence. We usually start our lessons by providing video-posts that explain some particular scientific content in an approachable visual way. This helps the teacher to introduce the terms and simple definitions of basic scientific concepts. It is important to make sure that the input provided helps to lower the *affective filter* (Krashen, 1982) and spurs scientific curiosity. At this point, only a few students will be able to produce some kind of explanation for what they are watching: some students still lack the necessary scientific knowledge to understand the video; others have not yet been exposed to the necessary quantity of discourse to get familiar both with terminology and collocations and with the process of explaining; and some others still lack both scientific and language command. Therefore, further exposure to the scientific topic itself in the foreign language is very necessary. Correct use of sequenced video-posts and texts with a guide for understanding is crucial.

Output production needs to be adjusted to mixed ability and knowledge groups. Students fluent in Basic Interpersonal Communication Skills in English perhaps need to be reminded that accurate use of scientific terminology is important; paraphrasing is good for clarification but still they need to focus on formal aspects of discourse, that is, an accurate Cognitive Academic Language Proficiency. On the contrary, more timid students perhaps need to be encouraged to linger on the concepts and say things "in their own words". Both tasks may be very difficult, as you are forcing learners to use those strategies which are opposite to their learning styles; but good science teaching cannot be done without the two of them. In order to facilitate output development in both directions, some key aspects seem to be essential, such as: providing guides for the detailed description of concrete processes and abstract ideas; working in mixed-ability member teams to produce conscious written explanations, or using spoken interaction with peers and lecturer to describe concepts or processes and ask for clarification.

It is clear that correct input comprehension and output production in Natural Sciences cannot be performed without the help of visualization and experimentation. TBLT and CLIL therefore offer the methodological structure which supports the Foreign Language learning process.

PRACTICUM EXPERIENCE

One of the most important courses in Pre-service Teacher Training is school Practicum. It is the first contact of student teachers with Primary Education classes, where they have to deal with classroom management and pupils' characteristics. During Practicum placements, student teachers will plan, implement and evaluate their teaching practice. In this period, they will accomplish the essential dimensions of the teaching and learning processes (Roy, 1991). Practicum is the proper occasion for students to start planning their lessons and implementing them in bilingual classrooms.

Organization

The Faculty of Education and Social Work organizes this course in collaboration with the local education authorities, which select different schools and teachers to tutor and guide the students in their implementation phase. The Practicum is divided into two different periods. First, student teachers start observing the class dynamics with special emphasis on: the way school children work and behave in their groups; how the teacher builds and arranges lessons; and what kind of methodology is used. Second, they start practising with occasional activities in bilingual classrooms, so student teachers can get used to the way the school teacher works; meanwhile they plan their own Lesson Plan in Natural Science, always supervised by the teacher before and while it is being implemented.

During the process, the student's Faculty tutor: is in close contact with the school teacher; makes agreements on the Lesson Plan the student teachers will implement in Natural Sciences; and guides, observes and assesses the student during and after process. The Faculty Tutor is the ultimate person responsible for the student's training and assessment.

Theoretical Preparation

Regular meetings are held with the school teachers. This gives us the opportunity to know exactly what the schools need and exactly what kind of work our student teachers are expected to do in each class. In order to do that on time, the Lessons are planned and designed during the Foreign Language Methodology course sessions, adapting the contents and approach to each specific class to work with and practising the learning-by-doing principle taking into account all the factors included in the teaching and learning processes.

Just before starting their school internships, student teachers will meet with their Faculty tutors in four different two-hour sessions to specifically train for their school internships. Some of the issues to be tackled in the preparatory phase are: what, how and when to observe in the different school classrooms, and how to make their own notebook observations. Emphasis is placed on the fact that they need to put their analytical competences into action when they are observing a Natural Science lesson.

Monitoring meetings

During the internship Practicum meetings, carried out in the last two academic years (2014-2015 and 2015-2016), the process of reflecting about the experience was given priority. The main objective of the monitoring meetings is to train students into reflective teachers, following Richards & Lockhart (1994):

teaching involves a cognitive, affective, and behavioral dimension ([...]; Lynch, 1989). It is based on the assumption that what teachers do is a reflection of what they know and believe, and that teacher knowledge and “teacher thinking” provide the underlying framework or schema which guides the teacher’s classroom actions. (p. 30)

Clarke (1995) and Zabalza Beraza (2011) offer us the idea that a good teacher needs to be a reflective professional who should think about the how and why of the teaching and learning processes.

Therefore, we consider it important to tackle our student teachers’ beliefs regarding their future performance as teachers; since beliefs will be transferred to their teaching styles. As former school children, student teachers went through multiple educational experiences, which influenced their beliefs. Once they start their Pre-service Teacher Training, they are expected to become aware of and confront their preconceptions about teaching, and to transform them on a critical basis, accommodating both new theoretical knowledge, and -perhaps more importantly- new skills and beliefs originating from their interaction with the school reality and their school teachers’ teaching styles.

In the monitoring meetings, students can share their experiences and the difficulties found during the implementation of their Lesson Plans. All of them reflect about the situation of the classes and the problems that have arisen, the group analyse all the situations and transfer the individual experiences in order to make decisions and try to help each other to surpass difficulties. Meanwhile, Faculty tu-

tor and peer assessment give the student teachers the opportunity to improve their practice.

Last but not least, we should state that involving the student teachers in these tasks undoubtedly allows them to be aware of the importance of initiating their Continuous Professional Development (Caena, 2011; Desimone, 2009; Scott, 2010) from the perspective of *Lifelong Learning*.

CONCLUSIONS

At this point in the development of SciencePro Project, it is useful to gather together a set of far-reaching potentialities in terms of contributions, reflections, responses or attempts at responses, intended to have an impact on the evolving nature of the Project. Likewise, we need to take into account some limitations which have become apparent over time.

This Project began with the purpose of remedying some weaknesses detected in the teaching and learning processes of Natural Science taught through a Foreign Language. The weaknesses are now turning into both strengths and challenges, that is, the initial shortcomings found have been viewed as starting points in order to reorient the Pre-service Teacher Training, particularly in the teaching process of the subjects involved.

Regarding the strengths of the Project, its own interdisciplinary nature should be stressed, since it is primarily nurtured by the three areas of knowledge mentioned above: Didactics of Language and Literature, English Philology and Didactics of Experimental Sciences. The convergence of these areas fosters collaborative work in university classrooms by providing methodological and content support. For instance, the Foreign Language Methodology lecturer could occasionally be helped by the expert in Didactics of Experimental Sciences, and so forth.

The close relationship between the university lecturers and the school teachers is another key point which should be mentioned. This is, in fact, what truly offers the sense of being professionally coherent, as well as being what makes students capable of understanding the appropriate meaning of this teaching approach.

Throughout the implementation of the Project, we have learned that the repertoire of professional competences of students in Pre-service Teacher Training has been broadened, as our methodology gravitates towards the development of the procedural dimension of such competences. This argument is supported by all the evidence tested out from both the students' tasks and the information revealed by their corresponding school tutors during the internships. Of course, from the set of evidence gathered we must admit that there are still some shortcomings,

above all in content transposition. This is expected to improve in future academic and school years.

Through the Practicum, in-service teachers offer us guidelines about the improvements required in Pre-service Teacher Training level (the professional coherence mentioned above); and student teachers put into practice their newly learned disciplinary contents and competences: specific scientific discourse in the foreign language, scientific knowledge and skills, CLIL approach in and for real contexts of scientific experimentation.

For student teachers, the fact of being able to test out their knowledge over a short-time period will increase their motivation. For the SciencePro team, the Practicum is a means to test out the adequacy and effectiveness of their teaching practice and the improvement of student teachers' professional competences.

Regarding limitations, the number of lecture hours that can be devoted to specific training in bilingual education is still low. More hours are needed to improve the project, and we hope that education authorities at University and Primary levels can work together in this direction.

All the findings collected along the existence of this project are leading us to rethink Higher Education curricula and syllabi, which should take on board more down-to-earth approaches. We understand that structural changes are needed in order to make a difference in this sense.

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